THE INSTABILITY OF LEAF-MORPHOLOGY IN ITS RELATION TO TAXONOMIC BOTANY.

By A. A. Hamilton.

In the ordinary routine-work of the Sydney National Herbarium, parcels of specimens are received from horticultural, agricultural, arboricultural, pastoral, and dairying districts accompanied by requests for information from the consignors, Farmers, Stock-Inspectors, Shire Clerks (administering the "Noxious Weeds Act"), Foresters, Secretaries of Agricultural Bureaux, School-Teachers, and other correspondents who do not profess any knowledge of systematic botany. As a consequence, the specimens forwarded, in many cases, are examples in leaf only; and the difficulty in determining such specimens, arising from the absence of the definite characters exhibited by the flowers and fruits, especially in the case of economic plants or those suspected of poisoning stock, to which considerable responsibility attaches, attracted the attention of the writer to the extensive range of leaf-variation found within the limits of a species, and a corresponding similarity in the leaves of distantly related plants. While engaged collecting a series of specimens to illustrate the ecology and xerophily of the strand-flora of Lady Robinson's Beach, a change in the leaves of *Senecio lautus* Forst., from flaccid, thin, and entire, at a distance from the beach, to crass, firm, succulent, and pinnatisect as the beach was approached (**13**; 1913, p.396), together with examples of *Clematis glycinoides* DC., exhibiting a gradual reduction of the normal trifoliate leaf, to a simple one, occurring on an individual plant, (*loc. cit.*) accentuated the impression already created. Attention was directed to the subject in the field, and collections made, demonstrating, for the greater part, the variation of leaves within a species, and exhibited from time to time at the Meetings of this Society. A series of examples, chiefly Australian, most of them familiar to local workers and readily available, together with

references from the works of Australian botanists, illustrating the leaf-characters affected, is now submitted, and, in certain cases, evidence is offered as to the conditions operating in the production of leaf-variation. For exotic examples and more detailed causation, see Schimper(23) and Warming(25) The factors affecting leaf-morphology, examples of which are given, may be briefly summarised.

Edaphic. —The preference shown by certain plant-associations of our indigenous flora for a particular soil-formation has been demonstrated by local botanists and geologists (though further data on this interesting subject are desirable), and this influence is largely contributory to leaf-variation; the growth on a rich basaltic soil, compared with that inhabiting a poor sandstone formation, needs no comment, so obvious is the effect on the size and shape of the leaves in plants capable of adaption to both situations.

Climatic.—The degree of heat or cold encountered largely regulates the size, pilosity, texture, and glaucousness of leaves. The occurrence of similar forms of leaf in some species of alpine and desert plants, due to the climatic conditions obtaining in such regions, is noted in all ecological text-books; and plants approaching these inhospitable regions from stations in which the conditions are more temperate, exhibit variation, which, in some instances, may be traced by well marked gradations.

Exposure v. Shelter.—The adaptable, dry ridge, or elevated plateau habitué, alters its foliar characters in conformity with the conditions obtaining in the valley, or sheltered slope, when changing its habitat. The close association of plants (growing in exposed situations) for mutual protection and shelter, modifies the size of the leaf.

Elevation.—The measure of elevation is seen to affect leaves in size, pilosity, and texture. Examples of hairiness in alpine plants growing under xerophytic conditions, and glabrous forms growing as hygrophytes are given(16; p. 34).

Phenological.—Irregularity of rainfall is the principal agent in phenological leaf-change; a sudden, copious rain after a prolonged period of drought, accelerates the production of foliage which

cannot be maintained, when the supply of water is exhausted, the leafage, as a consequence, becoming attenuated. Heterophylly, and dimorphism, may (in part) be attributed to this cause.

Hydrophylly.—The degree of permanence of the water-supply (river, creek, lagoon, waterhole, &c.) necessitates elasticity in the leaf-characters of the individuals, or associations of plants frequenting these stations.

Instability of foothold.– One of the devices adapted as a protection against uprooting, by plants growing in the shallow pockets of soil in alpine situations, and exposed to fierce storm-blasts, is the rosetted form of basal leaf (**16**; p.33). This character is simulated by several swamp-dwellers, notably members of the Orders Goodeniaceæ and Droseraceæ, as a supporting agency in maintaining an upright position, and to counteract the laxity of the soil-conditions obtaining in a bog. An instance of a plant (*Goodenia dimorpha* Maiden & Betche) which had been prostrated by a storm, growing an extra, basal rosette on a branch which touched the ground, and rooting it to secure an anchorage, was given (**13**; 1914, p.470). The muddy, insecure environment of the saline estuary has imposed on its plant-guests the task of making provision for repelling tidal invasion; and similarity of leaf-characters has been brought about, through the use of the same protective devices, by *Zoysia pungens* Willd., and *Sporobolus virginicus* Humb. & Kunth, the convolute leaves of these estuarine grasses offering a minimum of resistance to the ebb and flow of the tide. The insecurity of the shifting sand-dune is, in some measure, responsible for similarity in the foliage of the carpet-forming species, *Mesembryanthemum edule* Linn., and *M. æquilaterale* Haw., though, in this, as in the previous examples, more potent factors than those indicated have also been engaged in moulding the leaf-characters of these plants.

Drainage.—Stagnant water lying at the roots of plants in clayey soils, clay-pans, and shallow rock-basins, appreciably alters the facies of the foliage. In hilly sandstone-country, sudden dessication, owing to rapid drainage after a copious rainfall, compels the dweller in such regions to modify the size and texture of its leaves.

Halophily.—Succulence is the predominating character noted in species growing in saline situations, which affects their leaf-morphology; and it has been demonstrated that the leaves of certain species are increased in size and thickness by their proximity to tidal waters. Characters evolved by the necessity for provision against the absorption of an undue quantity of sodium chloride have, in the case of many beach and estuarine plants, induced a degree of similarity in the leaves of plant-associations adopting a common device, and variation in groups dependent upon differing contrivances to obviate this danger.

Humous acidity.—The swamp-dwelling fraternity of plants supplies instances of similarity of foliage arising from the communal use of xerophytic devices tending to decrease the absorption of the swamp-water, which contains the elusive, deleterious compounds, known as humous acids.

Insolation v. Shade.—Among plant-associations growing in open sandstone-country incapable of carrying an arboreal vegetation, a similarity in foliage is displayed by species belonging to differing families, due to the common necessity for a reduced leaf-surface, with accompanying characters, calculated to minimise the injurious action of unbroken sunlight. The shade, and luxuriant food-supply afforded by the conditions obtaining in the "Brush" forest, have permitted an increase in the size and flaccidity of the leaves of its inhabitants, which has resulted in many resemblances in leaf-characters, in plants widely separated in relationship.

Juvenility v. Adolescence.—The variation attributable to the transition from juvenile to adult growth affects pilosity, viscidity, armature, marginal division, and axial altenation; the division of the young leaves (pinnate) in the genus Acacia, as opposed to the phyllodic character of the adult foliage, and the opposite or alternate arrangement of the juvenile or mature leaves of the genus Eucalyptus, is common knowledge. Characters, arising from protective devices adopted by the young leaves, are discarded when no longer necessary. Scabridities, and asperities become more conspicuous as the leaves age, owing to shrinkage in their texture. The foliage of young plants is frequently larger than that of older growths.

Transpiration.—The preventive measures adopted by plants against excessive transpiration are responsible for similarity, or variability in leaf-characters, according to the resultant effects of uniformity or opposition, arising from the methods used to regulate the loss of moisture.

Adaptability.—The plant possessing the ability to exist in a varied habitat must, of necessity, be capable of modifying its leaf-structure to conform with the changes in the environmental conditions, the phrase "common and variable" being exceptionally applicable to adaptable species.

Teratological.—The meristematic attack of microscopic insects probably plays a more important part in the moulding of leaf-characters than has been generally recognised. Leaf-twisting, and axial disarrangement of the alternation of whorls, may be set up by insect-attack or mechanical injury.

Most of the above factors are capable of demonstration, but there remain, the uncertain effect of heredity, and the still less known equation "Mutation," to exercise a disturbing influence on leaf-characterisation. The changes brought about by natural hybridisation, and cross-fertilisation, though still largely a matter for conjecture, cannot be disregarded in a consideration of the morphology of leaves.

Examples.

Ranunculaceæ.

The marginal toothing, the leaf-character separating *Clematis aristata* R.Br., from *C. glycinoides* DC., is inconstant; and variation in the leaflets of the latter has already been noted. The foliage of *Ranunculus plebeius* R.Br., and that of *R. hirtus* Bks. and Sol., are difficult to separate, hairiness, the character chiefly relied upon, being subject to age, and environmental conditions; the dissection of the leaves varies on the individual plant.

Dilleniaceæ.

The xerophytic leaves of several Hibbertias are so similar as to be of little value to the systematist; those of *H. linearis* R.Br., and *H. obtusifolia* DC., approach each other, and are finally inseparable.

Cruciferæ.

The flaccid leaves, ranging from simple to lyrate, and pinnatifid, of many Cruciferous plants, are generically similar, and frequently indistinguishable.

Violarieæ.

Leaf-divergence in *Ionidium filiforme* F.v.M., due to environmental conditions, was noted, and specimens from the Blue Mountains exhibited before this Society (**12**; p.392) showing, under hygrophytic conditions, a flaccid, elongated leaf $2\frac{1}{2}$ inches long; while, on examples from an elevated, dry ridge, the longest leaf found measured barely $\frac{1}{2}$ inch.

Portulaceæ.

Mr. A. H. S. Lucas brought living plants of *Claytonia australasica* Hk., from Mt. Kosciusko to Sydney, and found that the new shoots became perfectly glabrous, the glaucousness of the plant also disappearing, with the vestiture, under cultivation in a warmer climate(**16**; p.22).

Rutaceæ.

Exceptional heterophylly in *Zieria involucrata* R.Br., was demonstrated in a series of specimens from Valley Heights, exhibited before this Society(**12**; p.393). Mr. J. Stirling, F.L.S., (**24**; p.1052) remarks of *Zieria Smithii* Andr., var. *macrophylla*, "in specimens of this arborescent form, procured at different altitudes and situations as regards humidity, dryness, &c., differences in the leaves represented by thickness, and (in the subalpine vars.) in having a dense, stellate tomentum on the underside." Again, under *Boronia anemonifolia* A. Cunn.,(*l.c.*, p.1054) "the division of the leaves into pinnæ in some forms, and the pubescence of others, are not constant characters." Mr. Stirling also refers to leaf-variation in other Rutaceous plants, arising from differences in soil, climate, and elevation. The Blue Mountain representative of *B. polygalifolia* Sm., var. *robusta* Benth., is a xerophytic form of *B. anemonifolia* A. Cunn., the leaflets in the latter showing a gradual change as the plants attain a more luxuriant station(**13**; 1914, p.648). The hetero-

phyllous leaves of *B. ledifolia* Gay, a species well known to local botanists for its leaf-variation, are described(**4**; Vol. i., p.314) as simple, trifoliate, or rarely 5-, or even 7-foliate. Specimens from French's Forest (Coll. E. A. Holden; Sept., 1906), exhibited before this Society by Mr. J. H. Maiden, F.L.S., on behalf of Mr. T. Steel, F.L.S., with reference to a case of assumed hybridism, *B. floribunda* × *B. serrulata* Sm.,(These Proceedings, 1906, p.566) showed an interchange of leaf-characters between these two species, which was accentuated by further variation, in another example from Deewhy,(T. D. Mutch; August, 1915) exhibited for Mr. Maiden(**13**; 1915, p.419).

A series of specimens of *Eriostemon hispidulus* Sieb., from Springwood, illustrating leaf-variation in size, shape, margin, and length of petiole, was exhibited(**13**; 1915, p.415) taken from bushes growing under apparently similar, environmental conditions; and an additional series is here noted, from plants of *E. salicifolius* Sm., also growing under similar conditions, on a sandy flat at Woy Woy(A. A. Hamilton; June, 1915), ranging from broad lanceolate, 2 × $\frac{5}{8}$ inch, to narrow linear, 2× $\frac{1}{8}$ inch, and from $\frac{1}{2}$ to 3 inches long. Specimens of *Phebalium squamulosum* Vent., in the National Herbarium, show a considerable range of variation in the dimensions of the leaves of this widely distributed species, in several instances obviously due to environment; the scurfy scales vary in colour from red to black, the margins are from barely recurved to almost revolute, and the apices are from acuminate to broadly obtuse, truncate, or emarginate.

Meliaceæ.

Mr. Bentham's description of *Flindersia maculosa* F.v.M.,(Fl. Aust. i., p.389) is elastic.

Sapindaceæ.

The botanical description given by Mr. Maiden of *Atalaya hemiglauca* F v.M.,(**19**; ii., p.122, Pl.60) shows that the leaves of this species may be simple or pinnate, from 2-8 inches long, the petiole terete or winged, or the leaflets decurrent on the petiole, forming a large 2- or 3-lobed leaf, such a leaf being depicted as a

detail, in the carefully executed plate by Miss M. Flockton, illustrating this species. A series of leaves of *Dodonæa triquetra* Wendl., showing a considerable range of variation within this species, was exhibited before this Society(**13**; 1915, p.628).

Leguminosæ.

In this Order, the genus Acacia has presented many problems in leaf-variation to the systematist, the exceptionally wide range of habitat of many species of the genus necessitating considerable alterations in the structure of the foliage, to meet the requirements of the varied environmental conditions encountered within the sphere of their activities. An example of this elasticity is found in the alteration of the texture of its phyllodes, by *A. suaveolens* Willd., during its passage from the lower to the higher elevations on the Blue Mountains(**12**; 1915, p.389). In a footnote to his description of *A rostellifera*, Bentham, (**4**; ii, p.368) who has reduced *A. subbinervia* Meissn., to a synonym of his species, writes —"The second nerve of the phyllodia, from whence Meissner derived his name, very seldom occurs, and was therefore in some measure exceptional in the specimen described by him." Discussing the *A. decurrens* Willd., group of "Wattles," Mr. J. H. Maiden(**19**; iii., p.40) draws attention to the following points :—The pinnules of all vary more or less in each variety in length, breadth, and insertion. . . . . A decurrence of leaf-stalks is common to all. . . . . The indumentum is variable. . . . . The number of glands varies in each variety in the same tree. Further remarks by the author accentuate the wide range of variation within this group. Under *A pumila* Maiden & Baker, (**20**; p.87) is the following note by Messrs. Maiden & Betche :— "Since publication of this species, many additional localities have been discovered . . . . . and the additional material necessitates some modification of the description. The phyllodia are described as 6 lines long and 1 line broad; it should read instead, phyllodia from $\frac{1}{2}$ to nearly $1\frac{1}{2}$ inches long, 1 line broad in the short-leaved forms, considerably narrower in the long-leaved specimens." Mr. R. H. Cambage, F.L.S.,(**5**) illustrates some of the difficulties in discriminating between several members of this

genus on foliar characters, with special reference to venation and texture. In (5; 1900, p.595) he applies the test of brittleness to the phyllodes as a differentiating character between two closely allied species, incidentally mentioning that this test is of no value in dried specimens. In a later paper,(5; 1900, Mr. Cambage returns to this subject, and notes (p.719) that the species *A. homalophylla* A. Cunn., "Yarran," whose foliage was, by its clean break, separated from *A. Cambagei* R. T. Baker, "Gidgea," shares this character with *A. pendula* A. Cunn., "Myall," similarity in phyllodic texture between them being also noted. In his description of *A. difformis*, the author, Mr. R. T. Baker, F.L.S., (3; 1897, p.154) considers it necessary to explain, at some length, the differences in foliar characters between his species and *A. penninervis* Sieb., to avoid confusion between them, referring also to the variability in foliage found in the latter species and its vars. Examples of the pinnate-leaved *A. discolor* Willd.,(13; 1915, p.209) collected from a series of plants growing in company on the slope of a hill at Cook's River, emphasised the irregularity of the number of pinnæ, relied upon by Bentham (4; ii., p.318) to differentiate two groups, the range of the size of the leaflets as given in the description of this species (*l.c.*, p.414) also displaying insufficient elasticity. *A. implexa* Benth., (13; 1915, p.415) furnished evidence, by means of a series of phyllodes taken from a small colony of some half-dozen plants, evidently with a common parentage, growing on a sandstone-hill at Glenbrook, of morphological, foliar divergence within this species, more pronounced than that differentiating it from *A. Maideni* F.v.M., the texture, and venation of the foliage of these two species showing similarity. Dimorphic foliage, the result, in some instances, of seasonal growth, is not infrequent in this genus. Examples showing the lower phyllodes larger than the upper ones, others again with the larger phyllodes uppermost, and a specimen with two, opposing branches on a single stem whose phyllodes showed a considerable divergence, were noted (13; 1914, p.648). Variation was also noted in the phyllodia of *A. elongata* Sieb.,(13; 1914, p.397) and those of *A. suaveolens* Willd., of which

measurements were given (13; 1914, p.471); examples of this species were also exhibited to illustrate leaf-twisting (13; 1915, p.418) The phyllodia of the *A. falcata* Willd., *A. penninervis* Sieb., and *A. pycnantha* Benth., group are not easily separated on the characters of shape, size, texture, and venation, each of these species having a fairly wide range of these characters within itself. Specimens of *A. binervata* DC., in the National Herbarium, collected at Stanwell Park, by Mr. J. H. Maiden, have the following field-note by the collector—"Twigs from a young tree, phyllodes very wide, and tripleveined." Mr. Maiden's leaves are from 3 to above 4 inches long, and from $1\frac{1}{2}$ to 2 inches broad. A further series of this species collected in the same locality by the writer (August, 1915), from an old tree, are narrow and normally two-veined, ranging in size from $2 \times \frac{1}{2}$ to $6 \times \frac{3}{8}$ inch, and in shape from straight to falcate, with a long, acuminate apex. The description of Acacia-seedlings given by Mr. R. H. Cambage(7; p.97) discloses variation in shape, size, number of leaflets, degree of pilosity, colour, venation, length and dilation of petiole, and distance of internodes, in the seedling-plants. In a concluding note, Mr. Cambage says (p.118)—"In all the above descriptions the measurements quoted of the various parts of the seedlings are either the average lengths or the extremes so far met with, but in some cases the variation is so considerable that it seems likely further investigation may show that the greatest extremes of length have not yet been recorded."

The spiny leaves of *Daviesia acicularis* Sm., *D. ulicina* Sm., and *D genistifolia* A. Cunn., are progressively merged, and those of *D. latifolia* R.Br., and *D. corymbosa* Sm., are, in many instances, inseparable. Of the latter, Mr. Maiden (15: p.8), notes the commingling of glaucous and non-glaucous forms; and a series of leaves of this species illustrating variation was noted by the writer (13; 1914, p.254). Local botanical collectors have, probably without exception, noticed the variability in the foliage of *Dillwynia ericifolia* Sm., and the similarity in the leaves of other species within the genus. Mr. R. H. Cambage (5; 1900, p.600) records some very marked features in the foliage of *Cassia eremo-*

phila A. Cunn., showing gradations from flat to cylindrical, under varying climatic conditions. The influence of xerophytic or hygrophytic conditions on leaf-variation was illustrated by a series of examples, exhibited before this Society (13; 1915, p.418), of *Bossiæa heterophylla* Vent., (a species whose foliar instability is intimated by its specific name) in which the transition from a degree of aphylly, in the elevated, dry-ridge xerophyte, and harsh, diminutive foliage of its fellow of the dry claypan, to the broad, soft leaves of plants of this species living under hygrophytic conditions, was demonstrated; in these latter examples, to which under normal conditions a regular supply of water is assured, the flattened stems, and the persistence of the narrow, linear leaves in company with the broader ones (heterophylly), disclose a provision for a return, when necessary, to xerophytic conditions, as it was noted that the broad leaves exhibit extreme sensitiveness to drought-conditions, and respond by becoming deciduous. A series of specimens of *Platylobium formosum* Sm., exhibited before this Society (13; 1915, p.415) showed alterations in the size of leaf brought about by xerophytic versus hygrophytic conditions. It is noted that several genera of Western Australian Leguminosæ are exceptionally liable to marginal leaf-variation.

Saxifrageæ.

The alternation of seasons favourable or deterrent to plant-growth, has caused considerable leaf-variation in *Ceratopetalum gummiferum* Sm. In some examples from Cowan (Coll. A. A. Hamilton; May, 1915), the larger leaves are found on the tips of the branches; in others, the smaller leaves are so placed, and there is a third stage showing a branch on which the leaves are all small, and closely packed.

Droseraceæ.

The leaves of *Drosera peltata* Sm., and *D. auriculata* Backh., are identical, and those of some of the rosetted forms are barely separable.

Haloragеæ.

Variation in the emerged and submerged leaves occurs in the genus Myriophyllum. In both *Haloragis ceratophylla* Endl., and *H. heterophylla* Brongn, leaf-division occurs, varying from almost entire, to coarsely-toothed, and pinnatifid; and both are irregular in the alternation of their leaves.

Myrtaceæ.

In the N.O. Myrtaceæ, the genus Eucalyptus provides many instances of leaf-variation. The attention concentrated on the genus by leading Australian botanists, who have specialised in this sylvatic group, has resulted in a searching investigation of their structure, from the cotyledon to the mature tree, and has incidentally disclosed many examples of the difficulty of discriminating between some of its members on leaf-characterisation. Bentham (**4**; iii., p.186) says:—"The old division of the genus according to the opposite or alternate leaves is now found to be quite fallacious," and, *loc. cit.*, "The extraordinary differences in the foliage of many species at different periods of their growth add much to the ordinary difficulties arising from the gradual transition of varieties, races or species, one into the other." Again,(p.187) "It appeared quite useless in any manner to describe these sapling leaves in the several species where they have been observed, for they present at once the greatest similarity in the corresponding leaves of different species, and the greatest dissimilarity in the different leaves of the same species or specimens." Baron von Mueller(**22**) notes several instances, in his specific descriptions, of members of this genus exemplifying the instability of leaf-morphology as a terminological factor. In his preface to (**18**), the author, considering Variation in the Genus(p.6), offers some generalisations on the modification of leaf-characters, and, in the already published portion of this comprehensive work, has cited numerous instances of similarity of leaves in opposing, and variation within the compass of species, accompanied by plates showing differing forms of leaves. Modification of leaf-characters in *E. coricea* A. Cunn., referable to elevation (**16**; p.35) are noted by the author,

who writes, "The case of *E. coriacea* is a notable instance of the decreasing size, increased succulence, and glaucousness of the leaves, as the higher elevations are reached." Mr. Maiden also writes at some length on the question of the specific rank of *E. pulverulenta* Sims, on the validity of which species some doubt had been expressed by previous writers, chiefly in respect of the variability of leaf-characters (These Proceedings, 1901, p.547). In (**20**a), Mr. J. H. Maiden, referring to "A species in the making,"—akin to *E. melanophloia* F.v.M.,(p.233), says:—"We have been of course aware for many years how variable is the foliage of *E. melanophloia*, lanceolate-leaved forms being well known. Particulars may be found in (**18**; Part 12, p.71). . . . . Owing to changes of environment, it is very often the case that we have breaks, and in the present case we may have a break from *E melanophloia* in the direction of narrower, more petiolate leaves, with other minor differences." In (**20**b), Mr. Maiden, under *E. Risdoni* Hook. f.,(p.28) says:—"Perusal of p.175, and of Plate 32 of my work (**18**) will show that I had already confirmed Bentham's observation by noting 'lanceolate leaves are common on the tops of branches of *E. Risdoni*,' and Mr. Deane and I compared them with a similar phenomenon in *E. pulverulenta* (*cinerea*)." In a paper (**20**d, MS.), (extracts from which I have, by the courtesy of the author, been permitted to quote) Mr. Maiden, under Homoplasy, writes:—"In Eucalyptus, so often do organs (particularly leaves) simulate each other, that it is usually necessary to demand specimens exhibiting a full suite of organs, in order that species may be determined"; and he gives the following quotation from Daydon Jackson's "Life of Bentham" (p.217), "On 27th April, 1870, Mr. Wilson Saunders again contributed to the Linnean Society, a set of mimetic plants, as the President phrased it, "a very interesting exhibition of pairs of plants with almost identical foliage from very different natural orders . . . . very much alike when in leaf only, so as in many cases to be quite indistinguishable, eighteen pairs of them" (p.220). A further reference is given (*loc. cit.*) to "Nature," iv., p.11. In a Chapter on Provisional Species, the author, when considering Mature Leaves (Eucalyptus) says:—

"There is infinite variation here." In a reference to "Hybridism in the Genus," the author (*loc. cit.*) refers to a personal experience in a Eucalyptus-plantation in Algeria, where intermediate forms of planted species, displaying pronounced, morphological characters, were obtained from spontaneous seedling trees. Variation of leaf-characters within, and resemblance without a species, is recorded by Messrs. Baker and Smith(2). *E. dextropinea* R. T. Baker, is noted(p.38) to have leaves almost identical with those of *E. lævopinea* (of this work), and resembling also those of *E. obliqua* L'Her.; and(p.41) *E. lævopinea* "sucker-leaves alternate or rarely opposite . . . . . mature leaves varying in size and shape, petiole varying from ½ inch to 1 inch long." Mr. R. H. Cambage has devoted a considerable portion of his Presidential Address(6) to an exhaustive summary of the morphological characters of the leaves of Eucalypts, showing extensive variation brought about by the necessity for modifications of structure, position, and other characters, to enable them to meet the varying requirements occasioned by the conditions of soil, climate, and other ecological and xerophytic factors, affecting the functional organisms of the members of this difficult genus, in their varied habitats. This writer has also drawn attention to similarity in the texture of the leaves of *E. stricta* and *E. viridis* (5; 1900, p.602), and (*l.c.* p.203) great similarity in the leaves of *E. dumosa* and *E. oleosa* Further references bearing on this subject will be found in a series of botanical papers by Mr. Cambage(5). The question of hybridism in Eucalypts has been exhaustively treated in (18) and other publications by Mr. Maiden, and other specialists in the genus; and the evidence adduced contains examples of similarity in the leaves of apparently distinct species brought about (presumably) by this agency. The similarity in foliage resultant from xerophytic conditions in the small-leaved group of the Myrtaceæ, is well exemplified in the allied genera, *Micromyrtus* and *Bæckea*, the diminutive, triquetrous, more or less decussate leaves of *M. microphylla* Benth., being, with difficulty, separated from those of *B. brevifolia* DC. Succulence, due to a halophilous environment, has enlarged the leaves ef *Bæckea crenulata* R.Br., when growing on the coast or saline estuary, to

such an extent that the leaves of plants of this species, growing in a habitat unaffected by salinity, show as much variation relatively to the succulent form, as that obtaining between the leaves of two distinct species of this genus, e.g., *B. Gunniana* Schau., and *B diosmifolia* Rudge.

The growth which appeared on some bushes of the latter at Valley Heights, after a fire had run through them, presented a marked difference from that obtaining in the foliage of the unscathed plants. *B. densifolia* Sm., exhibits a foliar difference in examples growing in a sheltered position at Valley Heights, and those growing at Newnes Junction (3500 feet) exposed to the bleak "Westerlies" (**13**; 1914, p.254). The leaves of the xerophytic, coastal swamp-form of *Darwinia taxifolia* A. Cunn., are inferior in luxuriance to those of the same species growing on the poor but well drained sandstone-hills at Cowan.

An example of leaf-variation within a species, is given in *Angophora melanoxylon* R. T. Baker. In his description of this species, the author writes:—"The rare shape of some of the leaves (the lanceolate form) connect it with *A. intermedia*, whilst the rounded, auricular base of the predominant shaped leaf gives it some affinity to *A. subvelutina*." (These Proceedings, 1900, p.85). A series of leaves of *A. cordifolia* Cav., showing variation within this species was noted (**13**; 1915, p.487). Specimens showing leaf-variation in the suckers of a form of *A. intermedia* DC., taken from a series of young trees (over which a fire had passed), growing on the Wianamatta Shale, near Clyde Railway-Station, are here noted. Example 1 : two, lower whorls of sucker-leaves ternate, the remainder gradually passing into the adult stage, and all opposite. Example 2 : two, upper whorls of adult leaves ternate, with a pair of opposite, adult leaves immediately below, merging into the sucker-leaves, which are all, from these downwards, alternate. Example 3 : juvenile and adult leaves, all opposite. Example 4 : lower whorl of sucker-leaves, ternate, those above opposite. Example 5 : three, lower whorls ternate, and one pair above, opposite (all juvenile). Example 6 : all sucker-leaves ternate. An exceptional range in size, shape (basal and apical), length of petiole, etc., is shown in both the

juvenile and adult foliage. On example 1, a pair of leaves are seen coherent by their margins; the fusion exists along the greater part of their length, and they are, together, little broader than an individual normal leaf; the well-developed midrib of each leaf, and the deeply notched apex, disclose the unity.

In the hygrophytic group of this family, the leaf-characters show similarity as a result of the conditions of shade, shelter, moisture, and rich soil, found in the Brush Forest. The pendulous leaf, with its long, acuminate, dripping point, a device to throw off superfluous water, which, by remaining too long on the leaf, would interfere with transpiration (**23**; p.17) is found in the "Brush-Myrtles" of the allied genera, Myrtus and Eugenia, and the more distantly related *Syncarpia leptopetala* F.v.M. The similarity in the case of the "Myrtles" is enhanced by the glossy coating of the leaves, another factor engaged in expediting the exit of surplus moisture (*loc. cit.*). The inconstancy of the opposite versus alternate arrangement of the leaves in the genus Melaleuca, used by Bentham in his key to the species (**4**; iii., pp.125,126), as a differentiating sectional character, is a not infrequent source of difficulty to the systematist; and leaf-twisting, in certain members of the genus, is not an invariably reliable character.

Ficoideæ.

Similarity in the effect produced by the xerophytic conditions obtaining on the beach, is exemplified in the case of the heavy, triangular, succulent leaves of *Mesembryanthemum æquilaterale* Haw., and those of the introduced *M. edule* L., a resemblance doubtless responsible for the deferred detection of the latter species, until quite recently (**13**; 1913, p.396). Both plants are of the carpet-forming type, their heavy, succulent leaves eminently fitting them for existence on the shifting sand-dune.

Umbelliferæ.

Examples of some forms of *Siebera Billardieri* Benth., from Leura (A. A. Hamilton; January, 1915) with leaves from rotundate and $\frac{1}{4}$ inch to $\frac{1}{2}$ inch long, to narrow lanceolate and

$2\frac{1}{4}$ inches long, with intermediate examples showing an extensive range of variation in form and size, are now exhibited. Specimens of *Xanthosia pilosa* Rudge, (Cook's River; A. A. Hamilton; April, 1915) show variation in the leaves from $\frac{1}{4}$ inch to $1\frac{3}{4}$ inches in length, and from 2 lines to $\frac{3}{4}$ inch in width; they are almost sessile, or on petioles up to $\frac{3}{4}$ inch long, and have a tomentum ranging from pale grey to dull brown. Two specimens of the well known *Actinotus Helianthi* Labill., are exhibited, to illustrate the effects, on the foliage, of bad drainage.

Compositæ.

The leaves of *Brachycome diversifolia* Fisch., & Mey., and those of *B. stricta* DC., both range from simple to pinnatifid, many examples of these species being inseparable on the foliar characters. The radical and cauline leaves of most of the Brachycomes, and many other herbaceous composites, are differently shaped. The minute, clustered leaves of *Olearia floribunda* Benth., and *O. lepidophylla* Benth., show similarity; while their ubiquitous congener, *O. ramulosa* Benth., has numerous forms. Of the latter, Bentham (**4**; iii., p.477) says, "There are two principal forms, which are often distinguished as species, but only differ in the shape of the leaves." Specimens of *O. myrsinoides* F.v.M., were exhibited before this Society (**13**; 1914, p.159) showing leaf-variation due to environment, in dimensions, texture, and length of petiole; and it is now noted that the tomentum varies within this species, from dull red to silvery-white. Leaf-variation resultant from seasonal growth, was illustrated in a series of specimens of *Cassinia aculeata* R.Br.,(**13**; 1915, p.209); and three forms of *C. longifolia* R.Br., from Blue Mountain localities, showing leaf-variation, were exhibited (**13**; 1915, p.722). A change in the xerophytic, protective character from hairiness to viscidity, adopted by an old bush of *Helichrysum semipapposum* DC., was noted (**13**; 1915, p.289), young plants in its vicinity, evidently its progeny, retaining the pilose character. Mr. J. H. Maiden (**15**; p.18) notes three forms of *Helichrysum rosmarinifolium* Less., var. *thyrsoideum*, at different elevations on Mt. Kosciusko, the leaves varying in size, thick-

ness, and density of wool; and presents (**16**; p.34), under Piloism, instances in Compositæ, and other families, of an increased vestiture assumed by plants on the higher elevations, growing under xerophytic conditions. Plants of *Helipterum incanum* DC., growing in the Hartley Valley, near the banks of the Lett, show alterations in the leaves from short and broad, to narrow-linear, yellow, white, and variegated flowers being found among this series. Examples of this species in the National Herbarium, from Mt. Kosciusko (Coll. J. H. Maiden), have basal, obovate-spathulate leaves, 1 inch long; and there are examples from various localities with elongated, thread-like leaves reaching 4 inches in length. The adaptability of the weedy *Helichrysum apiculatum* DC., has given rise to a large series of forms, only equalled, perhaps, by the ubiquitous "Cudweed," *Gnaphalium japonicum* Thunb.

Goodeniaceæ.

Specimens of *Scaevola suaveolens* R.Br., and *S. microcarpa* Cav., were noted (**13**; 1914, p.397), exemplifying an insufficient range of herbarium-material, or field-experience, necessary for a reliable description, one of the characters depended upon to separate these two species (size of leaf) being shown to be inaccurately applied. A difference in size and texture is here noted, characterising the leaves of old and young plants of *Goodenia ovata* Sm., from Stanwell Park (A. A. Hamilton; August, 1915). *G. heterophylla* Sm., and *G. hederacea* Sm., can, with difficulty, be separated on the leaf-characters.

Epacrideæ.

The sheathing-leaves of *Sprengelia ponceletia* F.v.M., are similar to those of the short-leaved forms of *S. incarnata* Sm., the latter showing a considerable range in length of leaf. The genus Leucopogon has several species which cannot be separated on leaf-characters. *Acrotriche divaricata* R.Br., and *A. aggregata* R.Br., are inconstant in the leaf-characters separating them, viz., hirsuteness, and shade of colour on the underside of the leaves (**4**; iv., p.226). Of *Epacris crassifolia* R.Br., it is noted

(4; iv., p.237) that specimens from Port Jackson (near the sea), have large leaves, and others (summit of the Blue Mountains) have smaller leaves. The latter statement must be qualified by due regard for environmental conditions, as examples from the higher elevations on the Blue Mountains, growing under different conditions, also have large leaves, which approach in size and shape those of *E. obtusifolia* Sm.(13, 1915, p.721). Similar environmental conditions were noted (13; 1914, p.544) in the case of *E. reclinata* A. Cunn., and a transition in the foliage, from flaccid and pilose to rigid and glabrous, was observed.

Myrsinaceæ.

Irregular, marginal toothing occurs in *Myrsine variabilis* R.Br.; the presence of teeth on the young growth, and their absence on the leaves of adult branches, have frequently been noted.

Oleaceæ.

The leaves of *Notelæa ovata* R.Br., and those of *N. longifolia* Vent., approach each other, and are finally merged; leaves of the latter, exhibiting extensive variation, were noted (13; 1914, p.326). In a footnote to *N. longifolia*, Bentham (4; iv., p.299) says, "The northern and southern specimens belong almost entirely to the glabrous form, the pubescent one is chiefly about Port Jackson, and in the Blue Mountains, to New England, some of C. Stuart's specimens from the latter station being densely and softly pubescent all over." Venation, the leaf-character chiefly relied upon by Bentham (4; iv., p.300) to separate *N. microcarpa* R.Br., *N. ligustrina* Vent., and *N. linearis* Benth., is variable in each of these species, occasionally on the same specimen; and all three are beset with more or less conspicuous dots, a character ascribed by Bentham to *N. punctata* R.Br., only (*l.c.*).

Convolvulaceæ.

Specimens of *Ipomœa Pes-Caprœ* Roth., (Stanwell Park; Aug., 1915; A. A. Hamilton) showing variation in the length of the petiole of the leaves, in an individual plant, ranging from 1 inch to 4 inches, is here noted.

Solaneæ.

Under the genus *Solanum*, Bentham (4; iv., p.443) says:— "The distinction and determination of the numerous species of this genus . . . . . is attended with peculiar difficulties, the chief characters being derived from the very variable ones, of foliage, armature, and indumentum" Examples of the small, red-fruited, *S. stelligerum* Sm., are not infrequently found with some leaves armed with spines, and others without any, on the same plant. *S. vescum* F.v.M., and *S. aviculare* Forst., are inseparable on leaf-characters, both having simple, and variously divided leaves, occasionally on the same branch, each species exhibiting within itself a degree of foliar variability, equal to that existing between the two species.

Bignoniaceæ.

Specimens of *Tecoma australis* R.Br., were noted (13: 1914, p.397) showing variation in the size, and number of leaflets, and marginal division.

Myoporineæ.

Spencer le M. Moore (21; p.258) writes:—"*Pholidia gibbifolia* F.v.M., is a very singular plant. . . . . The chief peculiarity resides in the leaves, which are much reduced, appressed to the stem, and curiously tuberculated. Had the specimens described by me in this memoir as *P. homoplastica*, not been in flower when they were gathered, I should have concluded without hesitation that they must be referred to Mueller's species, for in habit, as in leaf, the two seem absolute counterparts."

Labiateæ.

Bentham, in his key to the genus *Prostanthera*, (4; v., p.92) says of *P. denticulata* R.Br., "Leaves from $\frac{1}{4}$ inch and ovate to 1 inch and linear, entire, sometimes echinate. Plant pubescent or nearly glabrous." *P. incisa* R.Br., and *P. Sieberi* Benth., approach each other in leaf-characters, the latter merging into *P. violacea* R.Br.

Proteaceæ.

This largely xerophilous Order is probably (among phanerogams) the worst offender against regularity in its leaf-system.

Of heterophylly within a species, and homoplasy in opposing species, and the gradual metamorphosis of the leaves of one species into those of another, this well named Order provides numerous examples. Members present at the Meeting of this Society in July, 1910, will recollect the remarkable series of examples illustrating interchangeable leaf-characters between three *Grevilleas*, viz., *G. Gaudichaudii* R.Br., *G acanthifolia* A. Cunn., and *G laurifolia* Sieb., exhibited by Mr. J. J. Fletcher, which he presented as evidence of reciprocal hybridism within these species (These Proceedings, 1910, p.433). The leaves of *Grevillea linearis* R.Br., and those of *G. sericea* R.Br., overlap, and, in some of the narrower forms, are not easily separated; the foliar characters dividing *G. sphacelata* R.Br., and *G. phylicoides* R.Br., are not strong. In all four of these *Grevilleas*, the tomentum—one of the characters relied on by Bentham (4; v., p.464) to separate the two latter – is subject to considerable interchangeable variation, both in colour (silvery to ferrugineous), and flocculence, as opposed to appression. A series of examples of *G. oleoides* Sieb., are here noted, showing variation from narrow-linear, with revolute margins, to broad lanceolate, the margins but slightly recurved, and ranging from $3 \times \frac{1}{16}$ to $3 \times \frac{3}{4}$ inch (Heathcote; October, 1915; A. A. Hamilton).

Spencer Moore (21; p.259) says, "some Proteaceæ, *Grevilleas* and *Hakeas* especially, can scarcely be distinguished from Acacias when not in flower or fruit." The terete-leaved Hakeas, which exhibit, within the limits of a species (13; 1915, p.289, *H. pugioniformis* Cav.), as great a variation as is found in opposing species, are gradually altered viâ the dimorphic-leaved *H. microcarpa* R.Br., into the flat-leaved section of which the variable *H. dactyloides* (13; 1914, p.88) is a representative. The leaf-variation in *H. dactyloides* has been noted by Mr. J. H. Maiden (19; v., p.147, Pl.179), and several forms of leaf are depicted in the admirable plate by Miss M. Flockton, illustrating this species. A xerophytic condition inducing similarity in the leaves of certain members of a species, and causing variation between them and their congeners of the same species, which are not subjected to similar treatment, is exemplified in *Isopogon ane-*

monifolius R.Br., (13; 1915, p.118), and *Hakea pugioniformis* Cav., (*l.c.*, p.289) the latter species being also used to illustrate ecological, varietal effects (*l.c.*).

The leaves of *Petrophila pulchella* R.Br., *P. pedunculata* R.Br., and *P. sessilis* Sieb., are difficult to separate, and similarity exists between the leaves of all three, and *Isopogon anethifolius* R.Br.(13; 1915, p.419).

The genus *Persoonia* provides a foliar range from the acicular leaves of *P. pinifolia* R.Br., to those of the exceptionally large, broad, flat leaves of *P. salicina* Pers. The latter species offers a wide range of leaf-variation (13; 1914, p.648, as opposed to the similarity existing in the foliage of *P. media* R.Br., and *P. cornifolia* A. Cunn, the length and venation of the leaves, (characters used to separate the two latter, 4; v., pp.391-392) showing inconstancy.

The Banksias exhibit a transformation in leaves from *B. ericifolia* L., to *B. spinulosa* Sm., and *B. marginata* Cav., leaving the systematist occasionally in doubt as to which species he should refer contiguous examples, the marginal toothing, and size of the leaves showing many irregularities. A series of leaves of *B. marginata* is figured on the plate illustrating that species (10; ii., p.12) showing a number of forms, with a considerable range of variation. Similarity, on the other hand, between the leaves of *B. serrata* L., and those of *B. œmula* R.Br., is very pronounced.

Examples of *Conospermum taxifolium* Sm., and *C. ericifolium* Sm.,(13; 1914, p.325) demonstrated the difficulty of separating these two species on leaf-characters. The two species of *Symphyonema* (endemic in New South Wales) are separated chiefly on the foliage, which is largely influenced by environment, the swamp-form of *S. montanum* R.Br., on the Blue Mountains, frequently producing leaves the counterpart of those of the swamp-dwelling, coastal *S. paludosum* R.Br. Attention is drawn to the similarity between the leaves of certain species of the Order Proteaceæ, and others of the Sapindaceæ (9; 1900, p.586) by Mr. H. Deane; and the writer has shown examples of variation within a species in *Lomatia silaifolia* R.Br., (13; 1914, p.159),

L. longifolia R.Br., (*l.c.*; 1915, p.487), *Telopea speciosissima* R.Br., (*l.c.*; 1908, p.286, and *l.c.*, 1914, p.325), and *Xylomelum pyriforme* Sm., (*l.c.*, 1915, p.289) [the latter also illustrating the well known diversity in marginal toothing, between the juvenile and mature foliage], from time to time, at the Meetings of this Society. As is the case with the Order Leguminosæ, many genera of Western Australian Proteaceæ are exceptionally liable to variation in marginal leaf-division, and dimorphism.

THYMELEÆ.

Many specimens of *Pimelea* are uncertain in the alternation of the leaves, and the venation is also variable. *P. linifolia* Sm., an exceptionally adaptable species, and consequently widely distributed, has altered its foliar characters to meet the exigencies of its varied environment. One of its forms is inseparable from *P. glauca* R.Br., on leaf-characters.

CASUARINEÆ.

Examples of *Casuarina glauca* Sieb., were exhibited (**13**; 1915, p.288) to illustrate the dislocation of the symmetry of the whorls of teeth (leaves), caused by larval attack

CONIFERÆ.

Leaf-twisting, due to mechanical injury, was demonstrated in specimens of *Podocarpus spinulosa* R.Br, exhibited before this Society (**13**; 1915, p.418). This character (leaf-twisting) is occasionally used to separate closely allied species, e.g., *Conospermum taxifolium* Sm., v. *C. ericifolium* Sm., and *Xyris complanata* R.Br., v. *X. gracilis* R.Br. In both cases cited, the character is interchangeable.

ORCHIDEÆ.

The cylindrical leaves of *Dendrobium teretifolium* R.Br., (examples of which from Tuggerah Lakes, April, 1914; Coll. A. A. Hamilton, are exhibited) range from $1\frac{1}{2}$ to 18 inches long, and are so similar to those of *D. striolatum* Reichb., that the smaller plants of each species appear identical when not in flower.

Similarity in the leafage is found in the members of the opposing Orders, Irideæ, and Amaryllideæ, in respect of scabridity, texture, and marginal toothing, the two former char-

acters varying considerably with the degree of moisture available. The succulent, cylindrical leaves of many Liliaceous plants are almost identical, and are equally like the leaves of some terrestrial orchids. *Triglochin procera* R.Br., when growing in mid-stream, and subject to a strong current, has flat leaves, which are permanently bent, and lie on the surface of the water, while the leaves of plants growing near the bank, or in the still waters of a lagoon, are upright and almost terete. In the Orders Juncaceæ, Restiaceæ, and Cyperaceæ, the leaves of many species are so similar, that they afford very little assistance to the taxonomist. The rigid, convolute, pungent-pointed leaves of *Zoysia pungens* Willd., are very similar to those of *Sporobolus virginicus* Kunth, when these plants are growing associated in a saline estuary, both having adopted the same xerophytic, protective agency against the natural forces operating against them, in their exposed habitat. *Schedonorus littoralis* Beauv., has rigid, pungent-pointed leaves, simulating those of a Juncus.

Conclusion.

A consideration of the varied influences brought to bear on the modification of the morphology of leaves, as demonstrated by the foregoing examples (which might be indefinitely multiplied), discloses, it is submitted, sufficient evidence to warrant the assertion that the foliar characters in herbarium-specimens should be cautiously advanced in the determination of a species. It has been shown that a specimen taken from an individual shrub may differ as much in its leaf-character from other examples taken from the same plant, or from a neighbouring shrub of the same species, as it would from one taken from a distinct species. The examples cited in this paper (p. 157) referring to the inaccurate description of the position of the simple and trifoliate leaves in *Zieria involucrata*, and the relative size of the leaves, in *Scævola suaveolens* and *S. microcarpa*, (p. 169) are instances which show the necessity for extensive field-work, and the examination of a large quantity of botanical material in respect of leaf-characters, before describing a species, or proposing a new variety, the elasticity of the plant frequently showing disregard

for the rigidity of the description. In following a botanical description with herbarium-material, frequently limited in quantity, and from few, and often obscure localities, the variations in foliage brought about by local conditions must, in the absence of such information, be largely speculative. Nor does the possession of a type-specimen entirely remove the difficulty, unless the environmental conditions under which the type existed are available. The most valuable assistant to the taxonomic botanist is personal observation of his flora *in situ*, but as this is frequently impracticable, the carefully compiled field-notes of competent observers, with a knowledge of the factors liable to affect the morphology of leaves, are extremely helpful. In this direction, the value of the numerous references embodied in the writings of local botanists (who are, without exception, field-botanists) to the influences at work on the alteration, in our native vegetation, of the characters relied upon by the systematist, cannot be overstated. The following expressions of opinion may be quoted. Bentham (**4**; iii., p.186), in his remarks on the genus Eucalyptus, says : "but to the botanist who is unable to compare them in a living state, the due limitation and classification of their species presents almost insuperable obstacles." In his Presidential Address to this Society (**8**; 1915, p.649), Mr. Henry Deane refers to the determination of plants from leaves, and quotes a Presidential Address to the Linnean Society in 1870, by Bentham, who points out the unreliability of determinations made on leaves only, and mentions that De Candolle had been in error as to Natural Orders of species of which he possessed leaves alone. Later (**9**; 1900, p.581) Mr. Deane stigmatises as ridiculous the case of a botanist who would attempt a classification and description of a hitherto unexplored flora on a collection of leaves, and notes (p.588), that Ettingshausen points out in his paper the impossibility of carrying out any system of classification on leaf-characters, offering examples of similarity in widely separated, and heterogeny in more closely allied plants. Mr. Deane in his paper(**9**), also tabulated a number of species, and supplied figures of leaves, instituting comparisons as to their similarity in opposing, and variation in allied plants, with special

reference to venation. In a paper published in the Botanical Gazette, University of Chicago Press (Vol.59, 1915, p.484) on "The Origin and Distribution of the Family Myrtaceæ," Mr. Edward M. Berry, referring to a paper on this subject by Mr. E. C Andrews, published in these Proceedings (1913, p.529), says (p.486), "for although in accordance with paleo-botanical usage I have identified numerous forms of Eucalyptus in the N. American Upper Cretaceous, I have long thought that these leaves represented ancestral forms of Eugenia or Myrica, but have hesitated suggesting any change based merely on personal opinion, and also from a consideration that such change in nomenclature is undesirable at the present time from the standpoint of stratigraphic paleobotany." Mr. J. H. Maiden(17: p.177) says:—"Except in the case of very characteristic material botanists who deal with the existing flora usually ask to be excused from determining a plant on a leaf only." In (20c, p.326), the author says:—"Other characters of Eucalyptus leaves we require to know more about, are their size, texture, and prominence of venation. They are minor characters, and some species present much variation in this respect"; and in (18; Part viii., p.247) Mr. Maiden says:—"I attach great importance to studying the trees in the field. . . . . In these researches I may be pardoned for saying that I have travelled more or less in every State of the Commonwealth, covering thousands of miles on foot in pursuit of this study alone, in contradistinction to mere herbarium work." Mr. E. C. Andrews(1), discussing "The Age of Dicotyledons," gives (p.360) examples of the difficulty of determining the correct botanical classification of existing plants on leaf-characters, showing differences of opinion among our greatest systematists, as to the family in which certain trifoliate-leaved plants should be placed. Sir J. D. Hooker (14; p.13), says:—"The result of my observations is that differences of habit, colour, hairiness, and outline of leaves . . . . are generally fallacious as specific marks, being attributable to external causes and easily obliterated under cultivation."

Specimens of the examples cited in this paper will be incorporated in the National Herbarium.

Since the foregoing was written, my attention has been drawn by Mr. Maiden to a reference on this subject in "A Text-Book of Botany," by Professors Coulter, Barnes, and Cowles, members of the Botanical Staff of the University of Chicago (1910-1911). In Vol. ii. of this work, which treats of Ecology, a chapter is devoted to "Variation in Leaf-Forms," (p.589) in which the authors note the value of the determination of the causes underlying leaf-forms, in relation to specific distinctions, and (*loc. cit.*) offer an hypothesis founded on species with an ancestral plasticity and fixed descendants, or possibly (pp.590-591) that some forms have always been rigid and others always plastic. "Form Variation in Amphibious Plants" is discussed (p.593), and examples given, showing the wide range of variation obtaining in the structure of the aërial and water-leaves of this aquatic group. Juvenile and adult leaves are considered (pp.596-597) in relation to ancestry, and the phenomenon of rejuvenescence, the latter being regarded as an indication of a sudden shock which causes the plant to return to a youthful stage. [An example of rejuvenescence in *Acacia floribunda* Willd., attributable to mechanical injury, is given by the writer(**13**; 1914, p.159), and a further example in *A. melanoxylon* R.Br., in which the cause of the change is not apparent (**13**: 1914, p.254)].

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